Chapter 4
NATURAL RESOURCES

The LWC Planning Area contains a variety of natural resources, ranging from coastal barrier islands, mangrove forests, bays, beaches and estuaries to inland freshwater-forested shrub, herbaceous wetlands, and upland habitats. This chapter provides an overview of these resources, discusses the water supply needs of natural resources, and describes some of the resource protection activities that are underway within the LWC Planning Area.

COASTAL RESOURCES

Southwest Florida has some of the most pristine and productive coastal waters within the state. Five of these areas are contained in aquatic preserves: Matlacha Pass, Pine Island Sound, Charlotte Harbor, Estero Bay, and Rookery Bay. Tourism, the major industry in Southwest Florida, is closely linked to its unique coastal resources. The coastal resources include areas such as estuarine systems, barrier islands and beaches.

Estuarine Systems

Coastal areas are dominated by large estuarine systems where the waters of the Gulf of Mexico mix with the freshwater inflows from numerous river systems, sloughs and overland sheetflow. These estuarine areas are characterized by shallow bays, extensive seagrass beds, and sand flats. Extensive mangrove forests dominate undeveloped areas of the shoreline. Two large open water estuarine systems, Charlotte Harbor and the Caloosahatchee River estuary, dominate the northwest portion of the LWC Planning Area. Other associated habitats are high salt marshes and riparian fringing marshes. More than 40 percent of Florida's rare, endangered or threatened species are found in Southwest Florida estuaries. One of the most renowned is the West Indian manatee, which depends on a healthy seagrass community as its major food source. The bald southern eagle also relies to a large extent on the estuary as its feeding grounds.

Coastal areas subject to tidal inundation support extensive mangrove forests and salt marsh areas. Coastal mangroves protect against erosion from storms and high tides, and assimilate nutrients from flowing water to produce organic matter (leaves), which forms the base of the estuarine food chain. Mangroves and salt marsh communities serve as important nursery and feeding grounds for many economically important species of finfish and shellfish, which in turn support migratory waterfowl, shore bird and wading bird populations. These brackish water communities were once commonly distributed along the entire coastline, but are now found in greatest abundance in Southwest Collier County and southern Lee County. The Ten Thousand Island region, which dominates the southern portion of Collier County, is the largest intact mangrove forest in the world.

Barrier Islands

Barrier islands form a chain from northern Lee County to southern Collier County. Barrier islands also protect the mainland from major storm events, act as a buffer for sensitive estuarine areas, and provide habitat for shorebirds and wildlife. These low lying, narrow strips of sand play an important role in the region's tourism economy by attracting visitors to the beaches.

Water Needs of the Coastal Resources

Maintenance of appropriate freshwater inflows is essential for a healthy estuarine system. Preliminary findings indicate that inflows to the Caloosahatchee Estuary ideally should have mean monthly values between 300 cfs and 2,801 cfs. Currently the mean daily flows range from 0 cfs to more than 13,652 cfs (Chamberlain and Doering, 1995). Excessive changes in freshwater inflows to the estuary result in imbalances beyond the tolerances of estuarine organisms. The retention of water within upland basins for water supply purposes can reduce inflows into the estuary and promote excessive salinities. Conversely, the inflow of large quantities of water into the estuary as a result of flood control activities can significantly reduce salinities and introduce storm water contaminants. In addition to the immediate impacts associated with dramatic changes in freshwater inflows, long-term cumulative changes in water quality constituents, water clarity, or rates of sedimentation may also adversely affect the estuarine community.

Estuarine biota are well adapted to natural seasonal changes in salinity. The temporary storage and concurrent decrease in velocity of flood waters within upstream wetlands aid in controlling the timing, duration and quantity of freshwater flows into the estuary. Upstream wetlands and their associated ground water systems serve as freshwater reservoirs for the maintenance of base flow discharges into the estuaries, providing favorable salinities for estuarine biota. During the wet season, upstream wetlands provide pulses of organic detritus which are exported down stream to the brackish water zone. These materials are an important link in the estuarine food chain.

Estuaries are important as nursery grounds for many commercially important fish species. Many freshwater wetland systems in the LWC Planning Area provide base flows to extensive estuarine systems in Lee, Collier, and Monroe counties. Wetlands as far inland as the Okaloacoochee Slough in Hendry County contribute to the base flows entering some of these estuarine systems. Maintenance of these base flows is crucial to propagation of many fish species that are the basis of extensive commercial and recreational fishing industries.

The estuarine environment is sensitive to freshwater releases, and disruption of the volume, distribution, circulation, temporal patterns of freshwater discharges could place severe stress on the entire ecosystem. “Such salinity patterns affect productivity, population distribution, community composition, predator-prey interactions, and food web structure in the inshore marine habitat. In many ways, salinity is a master ecological variable that controls important aspects of community structure and food web organization in coastal systems" (Myers and Ewel, 1990). Other aspects of water quality, such as turbidity, dissolved oxygen content, nutrient loads, and toxins, also affect functions of these areas (USFWS, 1990; USDA, 1989; Myers and Ewel, 1990).

INLAND RESOURCES

Inland portions of the LWC Planning Area include numerous freshwater swamps, sloughs, and marshes. A number of these systems are relatively pristine wetland areas and are recognized as having national and regional importance (e.g., Big Cypress National Preserve, Corkscrew Swamp Sanctuary, and Fakahatchee Strand). These wetland areas serve as important habitat for a wide variety of wildlife and have numerous hydrological functions. Before development of the region, inland areas were comprised of vast expanses of cypress and hardwood swamps, freshwater marshes, sloughs, and flatwoods. Scattered among these systems were oak/cabbage palm and tropical hammocks, coastal strand and xeric scrub habitats. A large portion of the area contained seasonally flooded wetlands which sheetflowed fresh water from the northeast to the southwest.

Water bodies within the LWC Planning Area include natural lakes, man-made surface water impoundments, rivers, and creeks.

Wetlands

Wetlands are transitional lands between uplands and aquatic systems (water bodies) and are typically defined by vegetation, soils, and hydrology. Chapter 62-340, F.A.C., provides the statewide methodology for delineating wetlands in Florida. In part, the Code includes the following definition of wetlands:

> Those areas that are inundated or saturated by surface water or ground water at a frequency and a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils.

Wetlands within the LWC Planning Area include swamps, marshes, bayheads, cypress domes and strands, sloughs, wet prairies, riparian wetland hardwoods, and mangrove swamps.

Functions and Values of Wetlands

Wetlands perform a number of hydrologic and biological functions which make them valuable to man. Hydrologic functions performed by wetlands include receiving and storing surface water runoff. This is important in controlling flooding, erosion, and sedimentation. Surface water that enters a wetland is stored until the wetland overflow capacity is reached and water is slowly released downstream. As the flow of water is slowed by wetland vegetation, sediments in the water (and chemicals bound to the sediments) drop out of the water column, improving water quality.

Wetlands also function hydrologically as ground water recharge-discharge areas. Wetlands may recharge the ground water when the water level of a wetland is higher than the water table. Conversely, ground water discharge to wetlands may occur when the water level of the wetland is lower than the water table of the surrounding land.

Biological wetland functions include providing habitat for fish and wildlife, including organisms classified as endangered, threatened, or species of special concern. Some species depend on wetlands for their entire existence, while other semi-aquatic and terrestrial organisms use wetlands during some part of their life cycle. Their dependence on wetlands may be for over-wintering, residence, feeding and reproduction, nursery areas, den sites, or corridors for movement. Wetlands are also an important link in the aquatic food web. They are important sites for microorganisms, invertebrates and forage fish which are consumed by predators such as amphibians, reptiles, wading birds and mammals.

Types of Wetlands

Inland or freshwater wetlands within the LWC Planning Area can be grouped into three major categories based on hydroperiod: permanently flooded or irregularly exposed; seasonally or semipermanently flooded; temporarily flooded or saturated; and, upland. The Florida Land Use and Cover Classification System (FLUCCS) was used to delineate wetland systems with in the LWC Planning Area. The FLUCCS map was created in 1998 using 1994-1995 aerial photography and is the most accurate representation of the LWC Planning Area. The hydroperiod categories were created by combining FLUCCS coverage classifications with the National Wetlands Inventory hydrologic classifications. The hydrologic categories are broadly defined as:

- **Permanently Flooded or Irregularly Exposed.** Water covers the substrate throughout the year in all years or the substrate is exposed by tides less often than daily. Corresponds to lakes, reservoirs, embayments, and major springs.
- **Seasonally or Semipermanently Flooded.** Surface water persists throughout the rainy season and much of the dry season in most years. When surface water is absent, the water table is at or very near the land surface. Seasonally flooded soils are saturated. Corresponds to swamps, sloughs, mixed wetland hardwoods, cypress, wetland forest mixed, freshwater marshes, sawgrass and or cattail, wet prairies, emergent and submergent aquatic vegetation.
- **Temporarily Flooded or Saturated.** Surface water is present for brief periods during the rainy season, but the water table usually lies below the soil surface for most of the year. Plants that grow in both uplands and wetlands are characteristic of this water regime. The substrate is saturated to the surface throughout the rainy season or for extended periods during the rainy season in most years. Surface water is seldom present. Corresponds to

cypress - pine - cabbage palm, wet prairie - with pine, intermittent ponds, pine - mesic oak, Brazilian pepper, melaleuca, and wax myrtle - willow.

Distribution of Wetlands

The updated wetland systems map of the LWC Planning Area is shown on **Plate 3**. Although numerous man-made impacts have altered the landscape, significant wetland systems remain in the LWC Planning Area.

Charlotte County

In eastern Charlotte County, a portion of Fred C. Babcock/Cecil M. Webb Wildlife Management Area and Telegraph Cypress Swamp cover nearly 10,000 acres. Both systems are diverse with a mixture of hydric pine flatwoods, cypress strands and marshes.

Collier County

In Collier County, major wetland areas include the Okaloacoochee Slough, Fakahatchee Strand, the Big Cypress National Preserve, and the Corkscrew Regional Ecosystem Watershed (CREW lands).

Okaloacoochee Slough. This slough is one of the two most important surface water flowways in Collier County, with Lake Trafford-CREW being the other (Gore, 1988). This slough system is composed largely of herbaceous plants with trees and shrubs scattered along its fringes and central portions. It provides habitat for a wide variety of wildlife such as the endangered Florida panther.

Fakahatchee Strand. The strand is the southwest branch of the Okaloacoochee Slough. The strand contains a diversity of plant communities such as, mixed hardwood swamps, cypress forest, prairies, hammocks, pine forest, and pond apple sloughs. There are at least 30 species of plants and animals in the strand that are considered endangered, threatened, or species of special concern (U.S. Fish and Wildlife Service, 1984).

Big Cypress National Preserve. The preserve encompasses a vast area (570,000 acres) within Collier County. Habitats within the preserve are primarily cypress forest, pine flatwoods and marshes. There are in excess of 100 species of plants and 20 species of animals in the preserve listed by the state as endangered or threatened.

Corkscrew Regional Ecosystem Watershed (CREW). CREW is a 60,000 acre project in Lee and Collier counties, consisting of Corkscrew Sanctuary, Corkscrew Swamp, Camp Keais Strand, Flint Pen Strand, and Bird Rookery Swamp. CREW lands are dominated by cypress forest, low pine flatwoods, hardwood hammocks, marshes, mixed swamps and ponds. This system provides valuable habitat which supports at least 65 species of plants and 12 species of animals listed by the state as endangered or threatened.

Glades County

The major wetland in western Glades County is Fisheating Creek. Fisheating Creek is an extensive riverine swamp system that forms a watershed covering hundreds of square miles. Although Fisheating Creek is located in the Kissimmee Basin Planning Area, it delineates the northern boundary of the LWC Planning Area. Fisheating Creek is the only free flowing tributary to Lake Okeechobee. The creek attenuates discharges from heavy storm events and improves water quality before the storm water enters the lake. The creek also serves as a feeding area for wading birds such as the endangered wood stork, white ibis, and great egrets, when stages in the marshes surrounding Lake Okeechobee are too high.

Hendry County

The Big Cypress Swamp occupies a large section of southern Hendry County, including part of the Big Cypress Seminole Indian Reservation. The area is characterized by cypress forests, small pine hammocks, and marshes. The headwaters of the Okaloacoochee Slough are in northern Hendry County. The slough extends southward to Collier County, where it eventually branches to the Fakahatchee Strand

Lee County

Major wetland areas in Lee County include the Six Mile Cypress Slough and Flint Pen Strand, which is within CREW. Six Mile Cypress Slough encompasses 2,000 acres in Lee County and is dominated by cypress, interspersed with numerous ponds. The native plant communities which fringe the slough are pine flatwoods, hardwoods, and wet prairies. Heavy infestation of melaleuca has occurred in the southern one-third of the slough.

Uplands

Upland communities in the LWC Planning Area include flatwoods, tropical hammocks and xeric scrub communities, with flatwoods being the dominant upland habitat. Flatwood communities are divided into two types: dry and hydric. Dry flatwood communities are characterized by an open canopy of slash pine with an understory of saw palmetto. However, dry flatwoods are located in a slightly higher elevation in the landscape and are rarely inundated. Hydric flatwood communities (wetlands) are vegetatively similar to dry flatwoods.

Large areas of flatwoods are found throughout Hendry and Lee counties, as well as portions of Charlotte, Glades and Collier counties. Upland flatwoods are the native habitats most effected by the expansion of citrus into Southwest Florida. Flatwoods are important habitat for a number of threatened or endangered species, such as the Florida panther, eastern indigo snake, red-cockaded woodpecker and gopher tortoise. Pine flatwoods have greater richness of vertebrate species than either sand pine scrub or dry grass prairies (Myers and Ewel, 1990).

Tropical hammocks are scattered throughout the LWC Planning Area. This diverse woody upland plant community occurs on elevated areas, often on Indian shell mounds along the coast, or on marl or limestone outcroppings inland. Tropical hammocks are not widespread in occurrence, and as a result of conversion to other land uses, tropical hammocks are among the most endangered ecological communities in South Florida.

Xeric, sand pine scrub communities most commonly occur along sand ridges and ancient dunes. The southernmost of these communities was once found on Marco Island in Collier County, but has since been lost to development. Sand pine scrub is most often associated with relic sand dunes formed when sea level was higher than it is today. These well drained sandy soils are important areas of aquifer recharge for coastal communities. The sand pine scrub is the most endangered ecological community present within the LWC Planning Area. It is rapidly being eliminated by conversion to other land uses.

Upland plant communities (e.g., flatwoods, sand pine scrub) serve as recharge areas, absorbing rainfall into soils where it is distributed into plant systems or stored underground within the aquifer. Ground water storage in upland areas reduces runoff during extreme rainfall events, while plant cover reduces erosion, and absorbs nutrients and other pollutants that might be generated during a storm event. With few exceptions, the functions and values attributed to wetlands also apply to upland systems. Upland and wetland systems are ecological continuums, existing and adapting to geomorphic variation. The classification of natural systems is artificial and tends to convey a message that they survive independently of each other. In reality, wetland and upland systems are interdependent on each other. To preserve the structure and functions of wetlands, the linkage between uplands and wetlands must be maintained (Mazzotti et al., 1992).

Water Needs of the Inland Environment

Both the needs and functions of natural systems must be considered as part of the overall water supply planning process. Regional water supply plans are developed to identify sufficient water source options to meet the demands of urban and agricultural uses while meeting the needs of the environment. Wetland and upland communities play an integral role in maintaining regional water supplies by allowing for natural recharge of the aquifers.

Wetland Water Supply Needs

Maintaining appropriate wetland hydrology (water levels and hydroperiod) is the single most critical factor in maintaining a viable wetland ecosystem (Duever, 1988; Mitch and Gosselink, 1986; Erwin, 1991). Rainfall, along with associated ground water and surface water inflows, is the primary source of water for the majority of wetlands in the LWC Planning Area. The natural variation in annual rainfall makes it difficult to determine what the typical water level or hydroperiod should be for a specific wetland system. Because wetlands exist along a continuous gradient, changes in the hydrologic regime may result in a change in the position of plant and animal communities along the gradient. The effects of hydrologic change are both complex and subtle. They are influenced by, and reflect regional processes and impacts as well as local ones (Gosselink et al., 1994). Hydrology, as well as other factors that influence wetland systems, such as fire, geology and soils, and climate, is further discussed in Appendix E.

James Gosselink states in a 1994 study on wetland protection from aquifer drawdown that a critical issue to be considered in the water supply planning process is how wellfield induced ground water drawdowns affect wetlands. An adverse environmental impact can be defined as: (1) a change in surface or shallow ground water hydrology that leads to a measurable change in the location of the boundary of a wetland; or (2) a measurable change in one or more structural components of a wetland as compared to control or reference wetlands, or to the impacted wetland before the change occurred (Gosselink et al., 1994). Lowered ground water tables in areas adjacent to wetland communities have been shown to decrease wetland surface water depths and shorten the hydroperiod (length of inundation).

Aquifer drawdown and its subsequent effect on wetlands are best measured using three parameters; severity (the depth of the drawdown), duration (the length of time), and frequency (how often that drawdown occurs. Shallow, low gradient wetlands, may be entirely eliminated by lowered water levels. Decreased wetland size reduces the available wildlife habitat and the area of vegetation capable of nutrient assimilation. Lowered water levels and reduced hydroperiod also: (a) induce a shift in community structure towards species characteristic of drier conditions; (b) reduce rates of primary and secondary aquatic production; (c) increase the destructiveness of fire; (d) cause the subsidence of organic soils; and (e) allow for exotic plant invasion (Gosselink et al., 1994).

Studies of Southwest Florida wetland communities indicate that species composition and community type are largely determined by water depth and hydroperiod (Carter et al., 1973; Duever, 1984; Duever et al., 1986). Some wetland types contain water depths of three feet or more and are inundated year round, while other community types are characterized by saturated soils or water depths of less than a few inches that inundate the land for relatively short periods of time during the wet season. Wetland flora and fauna adapted to deep water and long periods of inundation are generally not well adapted to shallow water or a shortened hydroperiod. Complete drainage of a wetland severely alters wetland community organization and species composition. Partial drainage of wetlands can be caused by ground water withdrawals in adjacent upland areas. These withdrawals effectively lower underlying water tables and “drain” wetlands (Rochow, 1989). Drainage facilities such as canals and retention reservoirs constructed near wetlands have a history of draining and reducing hydroperiods of South Florida wetlands (Erwin, 1991). A major concern of reduced water depths and hydroperiod within wetlands is the invasion of exotic plants such as melaleuca and Brazilian pepper.

Rainfall, along with associated ground water or surface water inflows, is the primary source of water for the majority of wetlands in the LWC Planning Area. Rainfall in South Florida is highly variable. Although the region has a distinct wet and dry season, the timing and amount of rainfall which falls upon a particular wetland varies widely from year to year. As a result, wetland hydroperiod also varies annually. Hydroperiod information collected from a wetland during a series of wet years may vary considerably from data collected during a dry year. This wide variation in annual rainfall makes it difficult to determine what the appropriate water level or hydroperiod should be for a specific wetland ecosystem. Determining appropriate water level or hydroperiod conditions for a wetland often requires a data collection effort that spans a sufficient period of record. Hofstetter and Sonenshein (1990) suggest alterations that shorten hydroperiods may be detectable within 8 to 10 years.

Several attempts have been made by researchers to define annual inflows and water budgets for some of the larger wetland ecosystems present within the LWC Planning Area such as the Big Cypress Swamp (Klein et al., 1970; Freiberger, 1972; Carter et al., 1973; Duever et al., 1979, 1986), Corkscrew Swamp (Duever et al., 1974, 1975, 1976, 1978), Fakahatchee Strand (Burns, 1984), and Six Mile Cypress Slough (Johnson Engineering et al., 1990). However, no data currently exists which quantifies the environmental water demands for the region.

Computer modeling at the District has historically focused on predicting either ground water levels or surface water runoff. The utility of these modeling efforts for evaluating wetland hydroperiod has been quite limited. In recent years, however, the District's Wetland Drawdown Study has gathered sufficient data to calibrate integrated surface and ground water models capable of simulating wetland hydroperiod in a more realistic manner. Although the data requirements tend to limit these modeling efforts to a very local scale, they can be used to predict the effect of groundwater stresses on wetland hydroperiod, and aid in the evaluation of criteria for wetland protection. This knowledge could be utilized in determining appropriate flows from wetlands through tributaries to the different estuaries in the LWC Planning Area.

Upland Water Needs

The water supply needs of upland plant communities are not well known. It is assumed that the upper six to ten feet of the surficial aquifer is utilized by forest and herbaceous plant vegetation. Flatwoods are the dominant upland habitat within the LWC Planning Area. These plant associations are characterized by low, flat topography and poorly drained, acidic, sandy soils. In the past this ecosystem was characterized by open pine woodlands and supported frequent fires (Myers and Ewel, 1990). Three factors (fire frequency, soil moisture, and hydrology) play important roles in maintaining plant community structure and function and are also considered important as determinants of the direction of plant community succession. Fire is the factor which most strongly influences the structure and composition of upland plant communities.

Fire, under natural conditions, maintains flatwoods as a stable and essentially nonsuccessional plant association. However, when the natural frequency of fire is altered by drainage improvements, construction of roads, or other fire barriers, flatwoods can succeed to several other plant community types. The nature of this succession depends on soil characteristics, hydrology, available seed sources or other local conditions (Myers and Ewel, 1990). The hydrology of upland plant communities varies with elevation and topography. Seasonal variations as well as local withdrawals from ground water play an important role in determining the type of upland vegetation that will develop.

Wildlife Water Supply Needs

In South Florida, the dominant physical factors which influence the species composition, distribution and abundance of wildlife are the annual pattern of rainfall, water level fluctuations, and fire, as well as occasional hurricanes, frosts and freezes. Biological factors such as predation, competition and feeding habits also play important roles in configuring wildlife communities.

Alterations in water depth and/or hydroperiod that result in changes to vegetative composition densities and diversity may lead to the degradation of fish and wildlife habitat. One of the causes of melaleuca infestation is a decrease in water table levels which, when a seed source is present, can result in monotypic stands of tightly packed trees that have the potential to cause a localized decrease in biodiversity.

Wetland vegetative productivity usually exceeds that of other habitat types. Reduction in size of a wetland reduces food production at the bottom of the food chain. Alterations of the seasonal wet and dry pattern can also cause impacts. “The life cycle of many species are tied to this cycle. Wood storks, for example, are unable to successfully fledge their young without the dry season concentration of food. Anything that interferes with the cycle, too much water in the dry season or not enough in the wet season, tends to reduce fish and wildlife populations” (University of Florida, Center for Government Responsibility, 1982).

Flooding of wetlands during the summer months initiates the production of aquatic plants such as attached algae (periphyton) and macrophyte communities. These plants are consumed by small fish and invertebrates. Maximum numbers of fish and invertebrates occur near the end of the wet season. As marsh water levels decline during the dry season, these organisms are concentrated into smaller and smaller pools of water where they become easy prey for wading birds and other species of wildlife. Fish and invertebrates are the major dietary components of South Florida wading and water bird populations. Wading bird nesting success is highly dependent upon the natural seasonal fluctuations in hydroperiod of these marsh systems and the concentration of food resources. Kahl (1964) and SFWMD (1992) link the nesting success of wood storks and white ibis to the hydrologic status of regional wetland systems.

PROTECTION OF NATURAL RESOURCES

The District protects and enhances natural resources through its restoration activities and with integrated planning, regulation and land acquisition programs. Regulatory programs include rules to protect, enhance, mitigate, monitor wetlands and water resources and rules that address water quantity and quality.

Wetland Policies

The District prevents adverse impacts to wetlands from ground water withdrawals by implementing numerous state laws (Appendix A) through the consumptive use permitting process, which limits drawdown beneath wetlands. The permitting process is based on interpretation and implementation of the law to ensure that wetlands are protected. The obligation to leave enough water in natural areas to maintain their functions and protect fish and wildlife is central to water supply planning in the LWC Planning Area.

The State Comprehensive Plan (Chapter 187, F.S.) states as a goal that Florida “shall maintain the functions of natural systems and the overall present level of surface and ground water quality.” The same document lists as a policy: “reserve from use that water necessary to support essential non-withdrawal demands, including navigation, recreation, and the protection of fish and wildlife.” The Water Resources Act of 1972 (Chapter 373, F.S.) states: “The minimum water level shall be the level of ground water in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.” The District's Water Supply Policy Document affirms that “the District recognizes the state policies which establish priority protection of the water supply required to maintain and enhance healthy natural systems.”

The extent to which wetland preservation conflicts with water supply development depends greatly on the approach of that development. For example, options that increase water storage relieve the conflict between wetlands and human development, as does appropriate location and design of wellfields or the use of surface water. The challenge is to accept wetland protection as a constraint and to protect wetlands from harm; and, develop the most reliable and cost effective water supply strategy.

Wellfield Location

Locating wellfields away from wetlands is an approach that can reduce local environmental effects but is not always easy to implement. Often the choice is reduced to either locating the wellfield in undeveloped areas with environmentally sensitive wetlands or in developed uplands where the potential for wellfield contamination is a serious concern.

Wetland Buffers

Another approach involves using man-made lakes or reservoirs as a buffer between wellfields and natural wetland systems. The water in these lakes act as a buffer by managing the local water table at a sufficient level to avoid impacts to nearby wetlands. The surface water that is available in these reservoirs can also be used to supplement ground water withdrawals.

Wellfield Impact Monitoring

The District began a research program in 1995 to support development of wetland drawdown criteria. The research project is broken down into three phases.

Phase I consisted of: (1) a literature review to determine if sufficient information is present to support existing drawdown criteria or to recommend new criteria; (2) ground water modeling; and (3) a scientific wetland expert workshop. This phase was completed in November, 1995.

Phase II consisted of: (1) determining the extent and severity of impacts, if possible, using a historical approach to determine impacts from ground water drawdowns through aerial photointerpretation; and (2) identify wetland sites throughout the District for well installation and hydrobiological monitoring. This phase was completed April 1997.

Phase III has two main objectives: (1) implement long-term hydrobiological monitoring at wetlands located along a gradient of drawdown in selected study sites; and (2) test hypotheses regarding: (a) the effects of ground water drawdowns on wet season biological productivity; (b) the dependence of surface soil moisture on the dry season water table position; (c) differences in ecosystem structure and function between wetlands subject to different amounts of drawdown; (d) the effects of local versus regional calibration of ground water models used in the permit application process; and (e) symptoms of impact observed during drought.

Site characterization and well drilling contracts are presently underway in the LWC Planning Area. Biological studies will facilitate the characterization of biotic communities of the selected wetland sites and development of nondestructive long-term monitoring methods. To date, inventories of plant, fish, aquatic insect, bird, moss, algae and amphibian populations have been conducted. Various sampling methods are presently under investigation for incorporation into a long-term monitoring effort.

At Flint Pen Strand, there are currently 13 agricultural monitoring sites with 16 associated wells, with an additional 9 monitoring sites with 10 associated wells. At the Stairstep project site (Corkscrew Mitigation Bank) there are 3 reference sites with 5 associated wells. These sites are currently being surveyed and outfitted with the appropriate instrumentation. Full scale implementation began in the spring of 1999.

The hydrologic and biologic consequences of ground water withdrawal from wellfields in the Northern Tampa Bay region have been documented by the Southwest Florida Water Management District (SWFWMD). After long-term monitoring of wells and wetland systems, the SWFWMD concluded that adverse impacts are especially evident in areas where ground water modeling of withdrawals indicates a drawdown of one foot or more. The type of impacts noted for marsh and cypress wetlands were as follows:

- Extensive invasion of weedy upland species
- Destructive fires
- Abnormally high treefall
- Excessive soil subsidence/fissuring

- Disappearance of wetland wildlife

The SWFWMD ground water modeling has also shown that it may take one to two decades for the full effect of wellfield pumpage to be realized. Therefore, actual water levels in newer wellfields, or in wellfields currently not pumping at their maximum permitted levels, could become lower in the future. For these and other reasons, SWFWMD suggests that continued environmental monitoring will be necessary to ensure that Florida's wetlands are adequately protected (Rochow, 1994).

Wetland Mitigation Banking

Wetland mitigation banking is a relatively new natural resource management concept which provides for the compensation of unavoidable wetland losses due to development. The Florida Environmental Reorganization Act of 1993 directed the water management districts and FDEP to participate in and encourage the establishment of public and private regional mitigation areas and mitigation banks. The act further directed water management districts and FDEP to adopt rules by 1994, that led to the state's mitigation banking rule (Chapter 62-342, F.A.C.), becoming effective January 1994. In 1996, the law was modified to further develop this program by providing for the acceptance of monetary donation as mitigation in District and FDEP endorsed offsite regional mitigation areas. The bill clarified service area requirement credit criteria and release schedules, assurances and provisions that apply equally to public and private banks. As a result, the District and FDEP will adopt rules to implement these provisions. Wetland mitigation banking does not apply to water use related impacts.

Surface Water Improvement and Management

Under the provisions of the Surface Water Improvement and Management (SWIM) Act, the SFWMD was required to develop and implement a SWIM plan to preserve protect and restore Lake Okeechobee. The Lake Okeechobee SWIM Plan was enacted in 1989 and had its second update in August 1997. The environmental element recognized that adverse impacts to the Caloosahatchee Estuary occur when regulatory releases are made through the C-43 Canal for lake flood protection purposes. Large, unnatural freshwater releases from the Lake through the C-43 to the Caloosahatchee Estuary alter the estuarine salinity gradient and transport significant quantities of sediment to the estuary. Biota within the Caloosahatchee Estuary, and near-shore grass beds can be negatively affected by these high volume discharges.

Minimum Flows and Levels

The purpose of establishing minimum flows and levels (MFLs) is to avoid diversions of water that would cause significant harm to the water resources or ecology of an area. The Florida Legislature has mandated that all water management districts establish MFLs for surface waters and aquifers within their jurisdiction. Section 373.042(1) defines the minimum flow as “the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.” It further defines the minimum level as the "level of ground water in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area." The District is further directed to use the best available information in establishing a minimum flow or a minimum level.

The overall purpose of Chapter 373 is to ensure the sustainability of water resources of the state (Section 373.016, F.S.). To carry out this responsibility, Chapter 373 provides the District with several tools, with varying levels of resource protection standards. MFLs play one part in this framework. Determination of the role of MFLs and the protection that they offer, versus other water resource tools available to the District, are discussed below.

The scope and context of MFLs protection rests with the definition of **significant harm**. The following discussion provides some context to the MFLs statute, including the significant harm standard, in relation to other water resource protection statutes.

Sustainability is the umbrella of water resource protection standards (Section 373.016, F.S.). Each water resource protection standard must fit into a statutory niche to achieve this overall goal. Pursuant to Parts II and IV of Chapter 373, surface water management and consumptive use permitting regulatory programs must prevent **harm** to the water resource. Whereas water shortage statutes dictate that permitted water supplies must be restricted from use to prevent **serious harm** to the water resources. Other protection tools include reservation of water for fish and wildlife, or health and safety (Section 373.223(3)), and aquifer zoning to prevent undesirable uses of the ground water (Section 373.036). By contrast, MFLs are set at the point at which **significant harm** to the water resources, or ecology, would occur. The levels of harm cited above, harm, significant harm, and serious harm, are relative resource protection terms, each playing a role in the ultimate goal of achieving a sustainable water resource.

Where does the significant harm standard lie in comparison to the consumptive use permitting and water shortage standards? The plain language of the standards of harm versus significant harm, although undefined by statute, implies that the minimum flow or level criteria should consider impacts that are more severe than those addressed by the consumptive use permitting harm standard, but less severe than the impacts addressed by the serious harm water shortage standard. The conceptual relationship among the terms harm, significant harm, and serious harm are shown in **Figure 11**.

Two water bodies within the LWC Planning Area are on the District's priority list for establishment of MFLs: the Caloosahatchee River and Estuary and the LWC aquifer system. Both of these are anticipated to be completed by the end of 2000. Additional information on these is provided in the Planning Document.

National Estuary Program

The Charlotte Harbor has been designated an estuary of national significance and is a component of the U.S. Environmental Protection Agency sponsored National Estuary

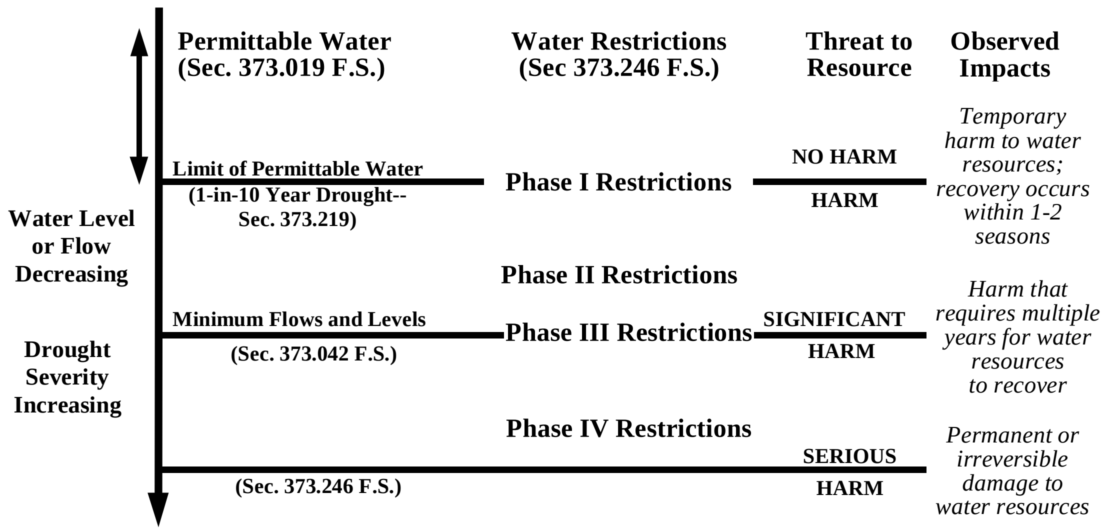

Figure 11. Conceptual Relationship among the Terms Harm, Significant Harm, and Serious Harm.

Program (NEP). The goals of the Charlotte Harbor National Estuary Program (CHNEP) include the following:

- Improve the environmental integrity of the Charlotte Harbor study area
- Preserve, restore, and enhance seagrass beds, coastal wetlands, barrier beaches, and functionally related uplands
- Reduce point and non-point sources of pollution to attain desired used of the estuary
- Provide the proper fresh water inflow to the estuary to ensure a balanced and productive ecosystem
- Develop and implement a strategy for public participation and education
- Develop and implement a strategy for public participation and education

Guided by these goals, the CHNEP published a Draft "Comprehensive Conservation and Management Plan (CCMP)" in November 1999. The CCMP details the actions needed to protect and improve the watershed while balancing human need with natural systems.

Land Acquisition and Preservation Programs

Natural resources in the LWC Planning Area that have been, or are proposed to be acquired for conservation/preservation purposes are shown on **Plate 4**. Ongoing acquisition programs in the LWC Planning Area are also discussed in Appendix E.

Save Our Rivers (SOR)

Florida's Save Our Rivers Program was started in 1981. The purpose of the SOR Program is to obtain fee simple or other interests in lands necessary for water management, water supply, and the conservation and protection of water resources. SOR acquisitions and proposed acquisitions within the LWC Planning Area are shown on **Plate 4**.

Conservation and Recreation Lands (CARL)

The CARL Program was established by the Florida Legislature in 1979. The primary purpose of this land acquisition program is conservation and protection of environmentally unique, irreplaceable ecological resources. CARL acquisitions within the LWC Planning Area are shown on **Plate 4**.

Local Programs

Several counties in the LWC Planning Area have initiated land preservation programs including Lee, Collier, and Charlotte counties.

Lee County

Lee County has acquired Six Mile Cypress Slough, a 2000-acre strand swamp, that parallels the course of the Caloosahatchee River. Acquisition was very much a grass roots effort. In the mid-1970s, after the slough failed to make the Environmentally Endangered Land (EEL) list, Six Mile Cypress Slough was enthusiastically adopted by students in the Lee County Environmental Education Program, under the direction of educator and former District Board member, William Hammond.

After a spirited campaign, voters approved a 0.2-mil, two-year tax for acquisition of the tract in November 1976. The acquisition effort moved slowly until the early 1980s, when $2 million of Save Our Rivers funds, administered by the District, were added. The acquisition area has since been expanded to 2,200 acres. One popular feature of the slough is the mile-long boardwalk, which is used by about 20,000 visitors annually. The Conservation 2020 Program adopted by voters in 1996, could generate as much as $77 million over a five-year period. Many of the lands being considered are already on the CARL lists.

Lee/Collier Counties

The Corkscrew Regional Ecosystem Watershed (CREW), created in 1989, is a 60,000-acre project surrounding the Corkscrew Sanctuary. In the mid-1980s, after several years of low rainfall, Lee County was motivated to apply for funds from the Save Our Rivers Program administered by the District to acquire the 15,000-acre Flint Pen Strand. The Corkscrew Sanctuary filed a separate application for lands within Collier County.

The District, hoping to acquire watershed lands in both counties as a unified project, created the CREW Trust, composed of representatives of several public and private agencies, to coordinate land acquisition, management, and public use. Approximately 21,000 acres have already been purchased from four major funding sources, including: the District (to become the ultimate project manager); Lee County; the Big Cypress National Preserve; and CARL (Lindblad, 1999). The Florida Wildlife Commission (FWC) is now preparing a management plan for the area. Recreation activities include a five-mile hiking trail, completed in 1994. A five-mile hiking trail was completed in 1994. Hunting may be permitted in the future, and four-wheeling will probably continue to be prohibited.

Charlotte County

The county has acquired 468 acres (former DRI known as Fairway Woodlands) adjacent to the Charlotte Harbor Flatwoods CARL project, Cedar Point. This project contains the following:

- An 88-acre peninsula next to Lemon Bay used for passive recreation and outdoor education
- Four eagle nests
- Tippicanoe Scrub
- Amberjack Slough

Charlotte County maintains conservation easements near Boca Grande and has conveyed easements to the FWC near the East Water Treatment Plant. These tracts were identified by the county's Environmental Lands Acquisition Advisory Council.